Saskatchewan

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Agriculture Development Fund

FINAL REPORT

19990357

EVALUATION OF ITALIAN MILLET FOR GRAIN PRODUCTION IN SASKATCHEWAN

Funded by
The Agriculture Development Fund

February 2002

Prepared by: University of Saskatchewan

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Saskatchewan Agriculture & Food

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ADF PROJECT 19990357

"EVALUATION OF ITALIAN MILLET FOR GRAIN PRODUCTION IN SASKATCHEWAN"

FINAL REPORT

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ABSTRACT

Italian millet (*Setaria italica*) accessions were evaluated at Saskatoon in 2000 and 2001. The initial set of eleven accessions under evaluation yielded significantly less than proso millet in 2000. A total of 730 new accessions were evaluated in screening nurseries in 2000 and 2001. From the first 380 accessions, 20 were deemed promising and yield-tested at two sites in 2001. Half of these lines yielded equal to or better than the proso millet check cultivar. These accessions were selected on the basis of earlier maturity and panicle size. Of the 350 accessions evaluated in 2001, five or six warrant further evaluation. The average yield of the most promising Italian millet lines was approximately 1,500 kg /ha in 2001, similar to the proso millet control. These results from this study indicate that, with some selection effort, Italian millet cultivars adapted to Saskatchewan could be developed to address the bird seed market.

EXECUTIVE SUMMARY

The primary objective of this project was to evaluate a type of millet called Italian millet (Setaria italica) for grain production in Saskatchewan relative to proso millet (Panicum milaceum). Italian millet is a major component of birdseed mixes but is not grown in Saskatchewan because of its late maturity. Italian millet can be seeded and harvested with conventional equipment. Millets tend to perform well under high temperature conditions and are physiologically similar to sorghum and corn. With the potential for an increasingly warmer climate in Saskatchewan, millet may prove to better adapted than temperate climate cereals in the future. Existing North American Italian millet cultivars are late-maturing and generally do not produce mature seed in Saskatchewan. German millet, a form of Italian millet, is used as a forage.

Italian millet accessions with yields equal to an adapted proso millet cultivar (AC Prairie Gold) were identified during the course of this project. The screening of a 730-entry collection identified approximately a dozen or so accessions that hold promise for cultivar development.

The average yield of AC Prairie Gold proso millet grown at two sites in 2001 was one-third of that achieved in 2000 while the average yield of the Italian millet check was 14% of that achieved in 2000. Of 20 elite Italian millet accessions, nearly half yielded equal to, or higher than, the proso millet control. These lines yielded 6 to 8 times higher than the Italian millet check cultivar. The higher-yielding lines headed 20 to 30 days earlier than the Italian millet check and matured up to 14 earlier. The same lines had higher test and kernel weights than the check cultivar. The average yield of the most promising Italian millet lines was approximately 1,500 kg /ha in 2001, similar to the proso millet control. For comparison purposes, yields of canaryseed seeded at the same time as the millet yield trial were in the range of 50 to 100 kg/ha in 2001. Thus, the earlier maturing millet accessions yielded 10 to 15 times higher than the canaryseed. Grain from the 2001 yield trial entries was analyzed for chemical composition. Protein content ranged from 10.4 to 16.5% while starch content ranged from 52.3 to 61.0%. Crude fat content ranged from 3.8 to 5.5% while ash ranged from 2.6 to 4.8% and TDF (total digestible fibre) from 17.1 to 22.7%. These results suggest that Italian millet is similar in protein level to wheat but lower in starch content and higher in oil content. These results are from only one growing environment. However, they do give a general idea of the grain quality of this crop.

The yields of the best accessions were significantly higher than those of canaryseed under the drought conditions encountered at Saskatoon in 2001. The crop appears to warrant further evaluation for eventual commercialization.

TECHNICAL REPORT

Objectives and Background to Project

The primary objective of this project was to evaluate a type of millet called Italian millet (Setaria italica) for grain production in Saskatchewan relative to proso millet (Panicum milaceum). Italian millet is a major component of birdseed mixes but is not grown in Saskatchewan because of its late maturity.

Saskatchewan has become a major exporter of canaryseed for use in bird (primarily canaries) feed mixtures. The proportion of canaryseed in feed mixtures varies with the bird species being fed. Canaryseed tends to be the most expensive component of the mixture. Millets (eg. Proso millet and Italian millet) tend to be used extensively. Millet prices are less than those of canaryseed (7 cents versus 12 cents/lb). However, the yield of proso millet tends to be 2 to 3 times higher than that of canaryseed under small plot growing conditions. In North Dakota, Italian millet yields are similar to those of proso millet. Italian millet is not produced in Saskatchewan although it constitutes up to 75% of the volume in birdseed mixes for caged exotic birds and budgies. Canada imports $3 million worth of millet from the USA per year. This includes both Italian and Proso millet.

In 1996, a cool crop year, we evaluated 27 accessions of Chinese origin. Most accessions did not produce a single panicle per plot. However, a single accession produced a few panicles containing mature seed. Seed from a single panicle was multiplied in 1997, yielding similarly to CWRS wheat (4,000 kg/ha on an experimental small plot basis).

In 1998 we conducted a strip trial comparing the highest yielding Italian millet line to tame oat. The forage quality of the two species was evaluated over 5 sampling dates during the summer. The results of that strip trial suggest that the two cereals are similar in green feed value.

The uncleaned grain yield of the Italian millet was approximately 3,800 kg/ha compared to 4,500 kg/ha for the tame oat (plot area = 80 meters square). A single sample of the Italian millet grain contained 61% starch, 12% protein and 4% lipid.

Results from 2000 yield-testing and germplasm evaluation

Eleven lines of Italian millet were evaluated in a four-replicate yield trial at Saskatoon in 2000. Each plot was 4.4 m square in size. An RCBD layout was used. Each plot consisted of four rows spaced 30 cm apart. The seeding rate was adjusted for kernel weight and set to 250 seeds/m2. The test was seeded on fallow on May 26. The plots were hand-weeded. The proso millet cultivar AC

Prairie Gold (TRT 12) was included in the yield trial for comparison purposes as there are no Italian millet cultivars registered for production in Canada.

The results from the yield trial are summarized in Table 1. The stand establishment of three of the millets was very good (90% plus) but poor to intermediate for the remaining eight lines. Two of the millet lines (Trts 5 and 11) yielded about 1,300 kg/ha. The yield of the remaining lines was very low, in part due to poor stands. 00MILL11 is a single panicle selection from 00MILL5, hence the similar performance of those lines. It is 00MILL11 that yielded similarly to CWRS wheat in 1997 and 1998. It is not clear as to why this line yielded poorly in 2000. However, drought conditions from early-May through to mid-June slowed growth of the Italian millet seedlings. Growth in July was good, but the crop was delayed in maturity, with heading taking place in mid-August. Most of the lines were killed by the first fall frost. Seed from all plots was subjected to a germination test 2 months after harvest. The germination of the millet lines ranged from 2 to 57%. Thus there were relative differences in maturity. Test weight and seed weight were determined for each plot of 00MILL5, 00MILL11 and AC Prairiegold. The test weight of the two millets was approximately 48 kg/hL and the seed weight about 1.8 mg per seed. Both Italian millets are yellow-seeded.
In 2000 the best adapted Italian millet lines headed out two weeks later than the proso millet control cultivar and yielded 60% less grain. The seed weight of Italian millet was a third of that of the proso millet cultivar. Yields of canaryseed planted at the same time as the millet yield trial were in the range of 1,000 to 1,500 kg/ha in 2000.

Table 1. Agronomic evalution of Italian Millet at Saskatoon in 2000

TRT ID	Grain yield (kg/ha)	DPE d	DTM d	Height cm	STD %	GER %	TWT kg/hL	1000K g
1 00MILL1	60	87.5	118.5	109.5	19	21	--	--
2 00MILL2	629	79.3	117.0	123.5	93	44	--	--
3 00MILL3	25	86.0	123.0	108.0	16	21	--	--
4 00MILL4	722	76.0	117.0	103.5	59	72	--	--
5 00MILL5	1373	76.8	117.0	107.0	99	57	47.9	1.9
6 00MILL6	30	87.5	121.5	107.5	16	13	--	--
7 00MILL7	12	92.5	123.0	113.5	49	6	--	--
8 00MILL8	54	92.8	123.0	108.0	55	18	--	--
9 00MILL9	106	79.3	123.0	114.0	35	2	--	--
10 00MILL10	26	93.3	123.0	109.0	60	9	--	--
11 00MILL11	1249	77.0	117.0	105.5	96	55	48.8	1.7
12 AC PRGLD	3753	60.0	102.0	100.0	100	98	75.7	5.8

DPE = days to panicle emergence; DTM = days to maturity; STD = plant stand; GER = germination of harvested grain; TWT = test weight; 1000K = kernel weight.

In order to determine whether the 11 millets yield tested in 2000 represented the earliest maturing germplasm available, the USDA collection was obtained (over 750 lines). In 2000, half of those lines were grown in hills (30 cm mini-rows) on fallow. Repeated hills of 00MILL11 were included

as controls. This nursery was hand-planted on fallow on May 26th. The nursery was hand-weeded. All hills that headed-out later than the control were culled from the nursery. Data for the control hills are summarized in Table 2. Of the 380 accessions grown, 47 headed equal to or earlier than the control. The data for those accessions is summarized in Table 3.

Table 2. Average performance of repeated check hills (00MILL11) in a germplasm evaluation nursery in 2000.

	Mean	SE	n
Days to panicle emergence	76.8	0.08	22
Plant Height (cm)	102.2	0.42	22
Days to maturity	22.8	0.18	22
Panicle length (cm)	19.8	0.23	22
Panicle cirumn. (cm)	8.7	0.19	22
Hill yield (g)	65.1	4.93	21

SE = standard error

It is apparent from the 2000 millet germplasm introduction nursery data presented in Table 3 that there was significant variation for maturity, plant height and panicle size among the accessions. Some of the accessions headed out 17 days earlier than the control. Others yielded twice as much as the control. Panicle length and circumference were measures since one of the markets for Italian millet is intact panicle used for bird food. The intact panicles are placed in the cages of small songbirds. The average panicle length for the control was 20 cm with a mid-panicle circumference of 7 cm. A number of accessions had panicles similar in size to the control. None of the selected accessions were US cultivars. Hence we continued to use the Chinese accession 00MILL11 as our "local" check.

Table 3. Means and ranges for 47 Italian millet accession hills harvested in 2000

	Average	Minimum	Maximum
Days to panicle emergence	70.21	49	77
Plant Height (cm)	86.8	60	114
Days to maturity	112.5	89	126
Panicle length (cm)	13.89	6	28
Panicle circumf. (cm)	5.55	3	12
Hill yield (g)	68.4	7.2	180

(b) 2001 yield test and introduction nursery results

Based on the results from 2000 introduction nursery I selected the best 20 accessions for evaluation in replicated yield testing at two sites, along with 00MILL11 and AC Prairiegold. The trial format was the same as in 2000. The Seed Farm (SF) trial was seeded on May 15th and the Kernen Farm (KCRF) trial on May 27th. Grain yields were higher in the SF trial, presumably

because of the earlier seeding date (Table 4). The average 2001 yield of AC Prairie Gold proso millet was one-third of that in 2000 while the average yield of 00MILL11 was 14% of that achieved in 2000. Of interest is the yield of the 01MILL lines. Of the 20 lines, nearly half yielded equal to, or higher than, the proso millet control. These lines yielded 6 to 8 times higher than the Italian millet line 00MILL11. The higher-yielding lines headed 20 to 30 days earlier than 00MILL1 and matured up to 14 earlier. The same lines had higher test and kernel weights than 00MILL11. The results of the 2001 replicated yield trials confirm the observations from the 2000 germplasm evaluation nursery, in that there exists significantly better adapted material than what we first evaluated in the form of the 00MILL series of lines. Yields of canaryseed seeded at the same time as the millet yield trial were in the range of 50 to 100 kg/ha in 2001. Thus, the earlier maturing millet accessions yielded 10 to 15 times higher than the canaryseed.

Table 4. Agronomic performance of selected Italian millet lines at two sites in 2001.

ENTRY #	LINE	YIELD KCRF kg/ha	YIELD SF kg/ha	YIELD % ACPG	DPE KCRF days	DPE SF days	DTM KCRF days	DTM SF days	HEIGHT KCRF cm	HEIGHT SF cm	TWT KCRF kg/hL	TWT SF kg/hL	1000KWT KCRF grams	1000KWT SF grams
1	00MILL11	25	332	14	90	93	110	124	77	94	27.0	45.9	1.04	2.24
2	AC PR.GOLD	871	1640	100	60	68	91	103	67	76	73.0	74.2	5.44	5.42
3	01MILL1	33	612	26	86	88	110	120	81	98		46.9	1.50	3.26
4	01MILL2	1534	2125	146	63	76	98	112	69	85	65.0	65.9	3.14	3.14
5	01MILL3	556	1075	65	63	73	96	103	63	74	54.0	55.4	2.78	2.72
6	01MILL4	313	1126	57	78	84	109	122	65	88	54.0	55.6	2.14	2.84
7	01MILL5	318	1476	71	86	86	110	119	59	85	54.0	64.0	1.68	2.60
8	01MILL6	806	1897	108	68	73	108	111	63	81	64.0	69.9	2.46	2.84
9	01MILL7	848	1687	101	71	78	107	116	69	81	63.0	64.4	2.08	2.62
10	01MILL8	623	1711	93	80	81	109	117	60	84	61.0	66.6	2.06	2.76
11	01MILL9	1269	1730	119	59	71	93	97	72	76	65.0	66.3	3.36	3.36
12	01MILL10	651	2098	109	70	77	109	116	47	71	61.0	66.3	2.30	3.06
13	01MILL11	592	1183	71	68	76	96	104	82	94	55.0	55.5	2.06	2.38
14	01MILL12	1240	1360	104	67	78	96	110	75	83	63.0	66.3	2.02	2.24
15	01MILL13	108	953	42	91	89	82	121	47	99	40.0	52.7	1.32	2.16
16	01MILL14	269	1342	64	83	79	109	86	55	84	50.0	63.7	1.70	3.00
17	01MILL15	1108	2205	132	70	78	104	113	64	76	66.0	68.0	2.66	3.02
18	01MILL16	1033	2055	123	68	76	107	115	36	70	64.0	66.6	2.94	3.12
19	01MILL17	492	1267	70	81	83	109	116	76	86	52.0	62.9	1.20	2.32
20	01MILL18	669	1763	97	75	78	101	100	69	98	61.0	64.3	1.50	2.06
21	01MILL19	486	1471	78	80	83	108	116	75	90	54.0	62.1	1.58	2.30
22	01MILL20	50	831	35	88	90	110	123	71	101		47.3	1.04	2.14
SE		140	118											

In 2001 the remaining 350 Italian millet accessions were grown in hills (30 cm mini-rows) on fallow. Repeated hills of 00MILL11 were included as controls. This nursery was hand-planted on fallow on May 30th. The nursery was hand-weeded. All hills that headed-out later than the control were culled from the nursery. Data for the control hills are summarized in Table 5. Of the 350 accessions grown, 38 headed equal to or earlier than the control. The data for those accessions is summarized in Table 6.

Table 5. Average performance of repeated check hills (00MILL11) in a germplasm evaluation nursery in 2001.

	Mean	SE	n
Days to panicle emergence	77.1	0.43	20
Plant Height (cm)	105.7	4.51	20
Days to maturity	108.3	0.23	20
Panicle length (cm)	12.9	0.50	20
Panicle cirumn. (cm)	7.3	0.32	20
Hill yield (g)	27.9	5.52	20

SE = standard error

Table 6. Means and ranges for 38 Italian millet accession hills harvested in 2001

	Average	Minimum	Maximum
Days to panicle emergence	69.3	53	82
Plant Height (cm)	91.0	70	125
Days to maturity	102.9	90	109
Panicle length (cm)	11.7	6	22
Panicle circumf. (cm)	4.7	3.2	8.0
Hill yield (g)	35.4	1.0	142

Grain from the 2001 yield trial entries grown in 2000 was analyzed for chemical composition (Table 7). Protein content ranged from 10.4 to 16.6% while starch content ranged from 52.3 to 61.0%. Crude fat content ranged from 3.8 to 5.5% while ash ranged from 2.6 to 4.8% and TDF (total digestible fibre) from 17.1 to 22.9%. These results suggest than the millet is similar in protein level to wheat but lower in starch content but higher in oil content. These results are from only one growing environment. However, they do give a general idea of the grain quality of this crop.

Table 7. Chemical composition of grain from 21 Italian millet lines

ENTRY TRT#	LINE	Moisture %	Protein % (db)	Starch % (db)	Crude fat % (db)	Ash % (db)	TDF % (db)
1	00MILL11	7.9	13.2	52.3	3.8	3.58	22.9
2	AC PR.GOLD	8.0	13.8	59.5	4.3	3.71	17.9
3	01MILL1	7.1	13.3	53.3	4.3	2.91	22.5
4	01MILL2	7.2	13.9	57.1	5.0	2.91	19.2
5	01MILL3	7.4	10.4	61.0	4.0	2.97	19.2
6	01MILL4	7.2	13.1	55.7	4.3	2.97	20.9
7	01MILL5	7.0	16.6	55.6	4.5	2.77	20.8
8	01MILL6	7.1	14.6	57.6	4.6	3.13	18.9
9	01MILL7	7.1	15.0	57.8	5.0	2.94	17.3
10	01MILL8	7.1	15.1	58.7	4.7	3.11	18.8
11	01MILL9	7.1	13.3	59.0	4.5	3.12	19.2
12	01MILL10	7.1	15.2	58.3	5.5	2.94	17.1
13	01MILL11	7.2	12.3	60.9	4.4	2.55	17.7
14	01MILL12	7.0	13.6	57.2	5.1	2.85	19.5
15	01MILL13	7.2	12.2	60.1	4.3	3.38	19.1
16	01MILL14	7.2	13.1	60.0	5.1	3.18	18.9
17	01MILL15	7.0	15.4	59.0	5.3	2.76	19.1
18	01MILL16	6.9	14.9	59.3	5.4	2.73	18.4
19	01MILL17	7.0	13.7	56.9	5.0	2.76	21.5
20	01MILL18	6.9	13.8	56.6	5.5	3.25	22.7
21	01MILL19	7.1	13.9	58.2	5.0	2.80	20.8
22	01MILL20	7.1	13.2	58.9	4.7	4.83	19.4

db= dry basis

CONCLUSIONS

Italian millet accessions with yields equal to an adapted proso millet cultivar were identified during the course of this study. The screening of a 730-entry collection identified approximately a dozen or so accessions that hold promise for cultivar development. The yields of the best accessions were significantly higher than those of canaryseed under the drought conditions encountered at Saskatoon in 2001. The crop appears to warrant further evaluation for eventual commercialization.

FURTHER DEVELOPMENT

The elite accessions identified in the 2001 yield trials and screening nursery warrant wider testing to determine how Italian millet is adapted to Saskatchewan crop growing regions. Millets tend to grow well under high-temperature conditions. Thus it would make sense to test the most promising lines in south and western Saskatchewan. If the yields are economically competitive, agronomic and weed control information should be collected.